42-079-00014

Jm
3/19/07

UGI Development Company

390 Route 11
P.O. Box 224
Hunlock Creek, PA 18621-0224
(570) 830-1269

February 28, 2007

CERTIFIED MAIL 7002 0860 0000 1118 2208

Mr. Jerome Curtin
United States Environmental Protection Agency
Region 3
1650 Arch Street
Philadelphia, PA 19103-2029

RE: UGI Development Company
RATA Notification - Unit No. 6
Oris Code - 3176

Dear Mr. Curtin:

Due to a scheduling conflict, UGI Development, Hunlock Power Station will be changing its Annual RATA Testing from April 16, 2007 to April 11, 2007.

If you should have any questions, please call me at (570) 830-1267.

Sincerely,

Jeffrey T. Steeber

Jeffrey T. Steeber
Staff Engineer
Hunlock Power Station

JTS:chet

112-579-00214

UGI Development Company

390 Route 11
P.O. Box 224
Hunlock Creek, PA 18621-0224
(570) 830-1269

February 13, 2007

RECEIVED
FEB 23 2007
Air Protection Division (3AP12)

CERTIFIED MAIL 7002 0860 0000 1118 2185

Mrs. Rene McLaughlin
3 AP 2
United States Environmental Protection Agency
Region 3
1650 Arch Street
Philadelphia, PA 19103-2025

RE: UGI Development Company
RATA Notification - Unit No. 6

Dear Mrs. McLaughlin:

This letter is to notify you that UGI Development Company, Hunlock Power Station is tentatively scheduled to perform the Annual RATA Testing on Hunlock Power Station's Unit No. 6 (Coal Unit) during the week of April 16, 2007.

If you should have any questions, please call me at (570) 830-1267.

Sincerely,

Jeffrey T. Steeber

Jeffrey T. Steeber
Staff Engineer
Hunlock Power Station

JTS:chet

CATALYST
AIR MANAGEMENT, INC.

AIR QUALITY TESTING SERVICES

UGI DEVELOPMENT COMPANY
HUNLOCK STATION
UNIT 6
ORIS CODE 3176

CEMS RATA PROTOCOL

Catalyst Air Management, Inc.
(Lab Registration No. 6-3118)
Project Number 124-033

JANUARY 30, 2007

2505 Byington-Solway Road
Knoxville, TN 37931
(865) 531-0075 • Fax (865) 531-0750

29541 Morningmist Drive
Wesley Chapel, FL 33543
(813) 994-5880 • Fax (813) 994-5571

10 Mill Road
Morgantown, PA 19543
(610) 913-7600 • Fax (610) 913-7608

CATALYST
AIR MANAGEMENT, INC.

UGI DEVELOPMENT COMPANY
HUNLOCK STATION
UNIT 6

CEMS RATA PROTOCOL

CATALYST AIR MANAGEMENT, INC.
(Lab Registration No. 6-3118)
PROJECT NUMBER 124-033

JANUARY 30, 2007

Prepared for
Mr. Jeff Steeber
UGI Development Company
Hunlock Station
US Route 11, PO Box 224
Hunlock Creek, PA 18621

CATALYST
AIR MANAGEMENT, INC.

STATEMENT OF VALIDITY

UGI Development Company – Hunlock Station
Catalyst Project 124-033
January 30, 2007

To the best of our knowledge, the applicable state and federal regulations, operating permits, or plan approvals applicable to each source and control device being tested have been reviewed and all the testing requirements have been incorporated into this test protocol.

Michael J. Taylor
President – Catalyst Air Management

Jeff Steeber
UGI Development Company

TABLE OF CONTENTS

PROJECT FACT SHEET

NAME OF SOURCE OWNER:	UGI Development Company
SOURCE IDENTIFICATION:	Hunlock Station Unit 6
LOCATION OF SOURCE:	Route 11, PO Box 224 Hunlock Creek, PA 18621
TYPE OF OPERATION:	Coal Fired Utility Steam Generator
TYPES OF TESTS PERFORMED:	Sample and Velocity Traverse-EPA Method 1 Volumetric Flow Rate-EPA Method 2F/H Oxygen/Carbon Dioxide-EPA Method 3A Moisture Content-EPA Method 4 Sulfur Dioxide-EPA Method 6C Nitrogen Oxide-EPA Method 7E Opacity-EPA Method 9
CEMS DESCRIPTION:	Air Monitor Mastron Flow - B26354 Thermo Environmental SO_2 - 43C-69110-362 Thermo Environmental NOx - 42C-69062-362 Thermo Environmental CO_2 - CHL-68209-359 United Sciences 500C-Opacity-07971306 VIM Technologies DAHS - Cemlink 5 2341
TEST COMPANY:	Catalyst Air Management, Inc. 2505 Byington-Solway Road Knoxville, TN
SITE SUPERVISOR:	Jeff Ferguson - Principal
TEST PERSONNEL:	Rick Derrera - Lead Technician Mark Williams - Technician
PROPOSED TEST DATES:	Week of April 16, 2007
OWNERS REPRESENTATIVE:	Jeff Steeber
TEST OBSERVER:	

1.0 Introduction

Catalyst Air Management, Inc. (Catalyst) has been contracted by UGI Development Company (UGI) to perform the Continuous Monitoring System (CEMS) Relative Accuracy Test Audit (RATA) for Unit 6 at the Hunlock Station in Hunlock Creek, PA.

The sampling program is scheduled for the week of April 16, 2007. The Catalyst contact is Mike Taylor (865) 531-0075 or Jeff Ferguson (610) 913-7600. Mr. Jeff Steeber of UGI will coordinate plant and CEMS operation during the testing.

2.0 Description of Process

The Hunlock Station, Unit 6, is a pulverized coal fired boiler. No.2 fuel oil is used for ignition and flame stabilization. The boiler is is rated at 400,000 lbs/hr of steam at 1350 psig and 955 °F. It is a Foster Wheeler drum type, wet bottom, arch fired, balanced draft unit with a nominal heat input of 562 mmBtu/hr. The steam is supplied to a turbine/generator rated at approximately 50 MW. The flue gas is passed through a primary and secondary precipitator for particulate control. A process flow diagram is included in the figures section.

3.0 Description of Sampling Locations

The Unit 6 stack is 40.5 feet high, with an inside diameter of 9.5 feet. The sampling location is approximately 14.5 upstream from the stack exit and 27 feet downstream of the inlet duct. A schematic of the sampling location is included in the figures section.

4.0 Description of CEMS

The Unit 6 CEMS is a dilution extraction system that measures SO_2, NOx and CO_2 concentrations at the sampling location. The CEMS analyzers include a Thermo Environmental Model 43H SO_2 analyzer, Thermo Environmental Model 42D NOx analyzer, Thermo Environmental Model 41CHL CO_2 analyzer and a Air Monitor Mastron Electron Flow monitor. The recording and reporting requirements are performed by a computerized data acquisition and handing system.

Unit 6 CEMS

(1) Thermo Environmental SO_2 - 43C - Serial No. - 43C-69110-362
(1) Thermo Environmental NOx - 42D - Serial No. - 42D-69062-362
(1) Thermo Environmental CO_2 - 41CHL - Serial No. - 41CHL-68209-359
(1) Air Monitor Mastron Electronic Flow- Serial No. B26354
VIM Technologies Data Acquisition and Handling System – Serial No.14787WIN

The analyzers measure on a wet basis. The data acquisition and handling system utilizes a Fc factor of 1910 scf/mmBtu to calculate NOx emissions in lbs/mmBtu.

5.0 Sampling Program Procedures

The following test methods were utilized during the test program:

EPA Method 1	Sample and Velocity Traverse for Stationary Sources
EPA Method 2F	Determination of Stack Gas Velocity and Volumetric Flow Rate with Three-dimensional Probes
EPA Method 2H	Determination of Stack Gas Velocity and Volumetric Flow Rate Taking into Account Velocity Decay Near the Stack Wall
EPA Method 3A	Gas Analysis for CO_2, O_2, Excess Air and Dry Molecular Weight (Instrumental Analyzer Method)
EPA Method 4	Determination of Moisture Content in Stack Gas
EPA Method 6C	Determination of Sulfur Dioxide Emissions from Stationary Sources (Instrumental Analyzer Method)
EPA Method 7E	Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Method)
EPA Method 9	Visual Determination of the Opacity of Emissions from Stationary Sources

5.1 NOx, SO_2 and CO_2 – EPA Methods 3A, 6C and 7E

A sample is continuously extracted and introduced into a Thermo Environmental Model 10, Chemiluminescent NOx analyzer, a Western Research Model 721, SO_2 analyzer and Servomex 1400 O_2/CO_2 analyzer for determination of gas concentrations. The sample is extracted through a heated stainless steel probe, heated sample line and sample conditioner to dry the sample before it enters the analyzers. A sample flow control system is used to control the flow into the analyzers. The analyzers are calibrated prior to starting the testing with EPA Protocol 1, calibration gases. A system bias check is performed before each run by introducing the zero and upscale gas at the back end of the sample probe. The system bias check is repeated at the end of each test run to determine the analyzer zero and calibration drift. Nine (9) to twelve (12) test runs will be conducted with each being twenty-one (21) minutes in duration.

The NOx analyzer spans are expected to be approximately 0-250 ppm. The SO_2 analyzer span is expected to be approximately 0-1000. The O_2/CO_2 analyzer spans will be approximately 0-25% and 0-20%, respectively. The calibration gases that will be utilized are zero, 40-60% and 80-100% of span. The high calibration gas will determine the span and be the bases for mid gas, as well as bias and drift calculations.

A stratification test will be performed to determine the number of sample points needed.

Reference Method Analyzers:

Manufacturer	Model	Pollutant	Span
TECO	10A	NOx	0-250 ppm
Western Research	721	SO_2	0-1000 ppm
Servomex	1400B	CO_2/O_2	0-20%/0-25%

5.2 Volumetric Flow Rate - EPA Method 2F/H

Traverse points and flow relative accuracy runs will be performed using EPA Methods 1, 2F, 2H, 3A and 4. The velocity and volumetric flow rate will be determined in accordance with procedures outlined in EPA Method 2F/H. A DAT prism 3-D probe is connected to a series of calibrated magnehelics and manometers to determine the yaw and pitch angles, static pressure and pitch coefficient of the flue gas at each traverse point. The temperature of the flue gas is also determined at each traverse point.

A minimum of nine (9) test runs will be performed at each load condition.

5.3 Moisture – EPA Method 4

The moisture content will be determined in accordance with procedures outlined in EPA Method 4. The flue gas sample is extracted from the gas stream and the moisture content is determined by measuring the increase in volume of the impingers. The sampling train consists of the following equipment connected in series:

Stainless steel heated sample probe
A modified Greenburg-Smith impinger containing 100 ml of H_2O
A Greenburg-Smith impinger containing 100 ml of H_2O
A modified Greenburg-Smith impinger, empty
A modified Greenburg-Smith impinger containing approximately 250g of silica gel

The sample volume is measured by passing it through a calibrated dry gas meter. After the run, the impinger contents are measured for increase in volume. The silica gel is returned to the original tared container and weighed to determine moisture gain.

A moisture determination will be performed with every pollutant test run and for every three (3) flow traverses.

5.4 F Factor Determination

Coal samples will be collected during the testing in order to determine the dry F factor used to calculate the emission rates in lb/mmBtu.

5.5 Opacity

The opacity monitor audit will be conducted by performing a minimum of nine (9) visible emissions evaluations. The visible emission evaluations will be 15 minutes in duration. Each of the evaluations will generate 15 - one minute averages that will be compared to the one minute averages generated by the CEMS during the same time period. A certified visible emission evaluator will conduct the audit.

All the procedures used for the RATA program were performed in accordance with the Code of Federal Regulations, Title 40, Part 60, Appendix A, and Appendix B, Performance Specifications 2, 3 and 6, Part 75 and the Source Testing Manual Rev 3.3.

6.0 Quality Assurance Procedures

The quality assurance procedures followed during the testing activities followed guidelines set forth by the previous mentioned methods and the EPA Quality Assurance Handbook for Source Sampling. The specific procedures for this test program are listed below.

6.1 Velocity/Volumetric Flow Rate

The 3-D probe will be visually inspected and calibrated to meet the design specifications of EPA Method 2F.

All legs of the probe will be leaked checked before and after each sample run.

The stack thermocouples will be calibrated prior to the testing and a post test check will be performed after the testing project.

The magnehelics will be leveled and zeroed before each sample run.

6.2 Moisture

The dry gas meter is fully calibrated annually using an EPA intermediate standard.

Post -test dry gas meter checks will be completed to verify the accuracy of the meter Yi.

Pre-test and post-test leak checks will be completed and were less than 0.02 cfm at the highest sampling vacuum.

6.3 Instrumental Methods

Analyzer calibrations, system bias check and drift checks will be completed before and after each sample run utilizing EPA Protocol calibration gases.

The NOx analyzer NO_2 to NO converter efficiency is determined in accordance with Section 16.2.2 of Method 7E.

The analyzer interference responses are determined in accordance with Section 8.2.7 of Method 7E and Section 16 of Method 6C.

7.0 Unit Operational Data

UGI will be responsible for the operation of the units and CEMS. UGI personnel will provide documentation for operational conditions maintained during the testing. The CEMS data acquisition and handling system (DAHS) will provide emissions data to determine the system relative accuracy.

8.0 Test Report

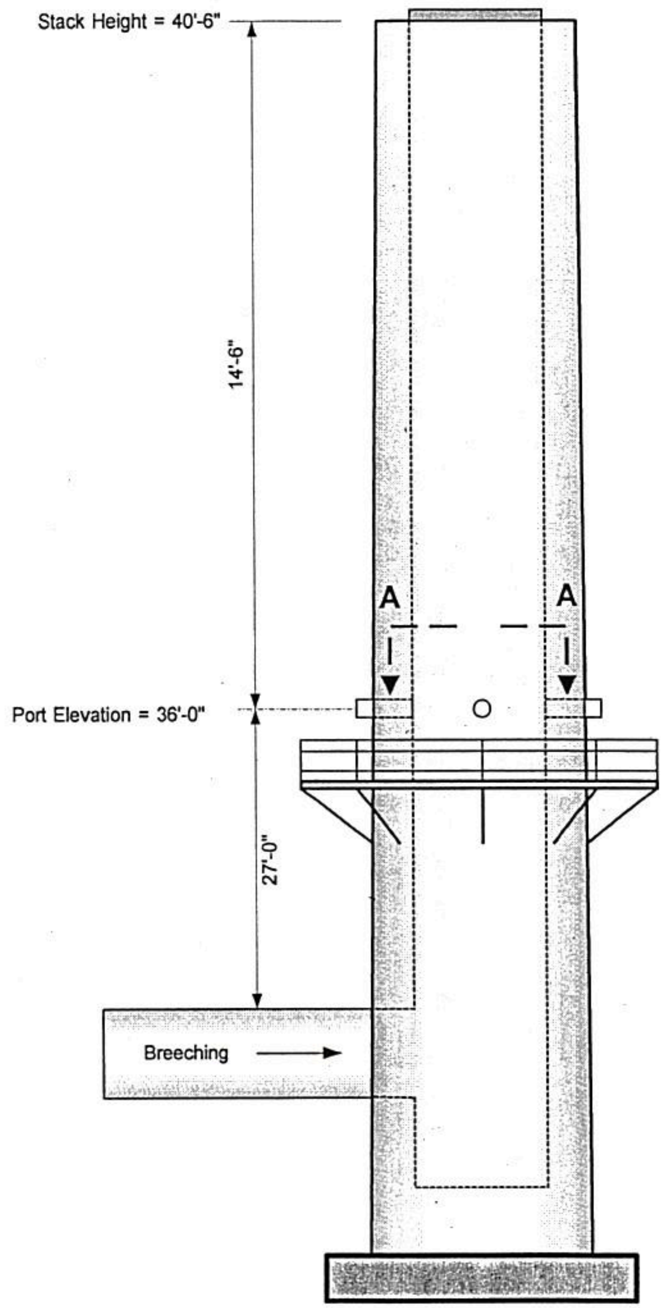
The test report will be submitted that will provide the results of the test program and all the pertinent information pertaining to the individual tests. The report will include the following:

- Unit description
- Sampling location and test points
- Unit operating data and production data
- Test personnel
- Test results and discussion of the test program
- Raw test data
- Equipment calibration and test method QA
- Sample Calculations

ATTACHMENT 1

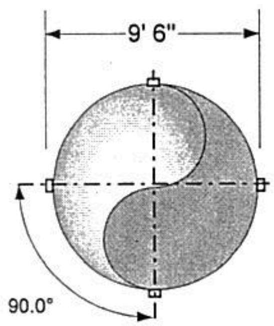
Figures

CATALYST
AIR MANAGEMENT, INC.



TRAVERSE POINTS (Typ 4 Ports)
FLOW
(Inches) from inside of stack.

1. 3.6"
2. 12.0"
3. 22.1"
4. 36.8"



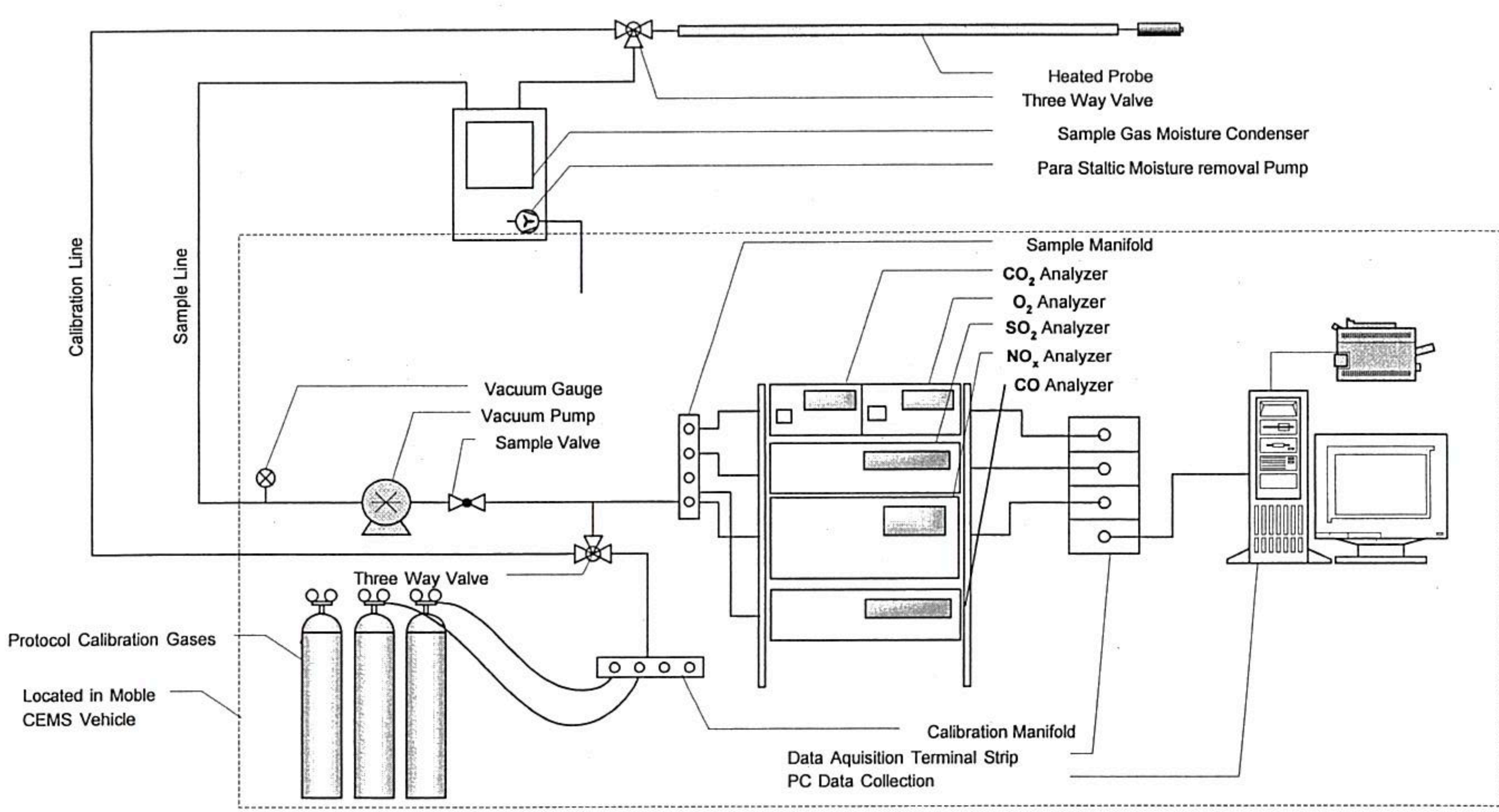
SECTION A - A

TRAVERSE POINTS (Typ 4 Ports)
(meters) from inside of stack.

1. 0.4
2. 1.2
3. 2.0

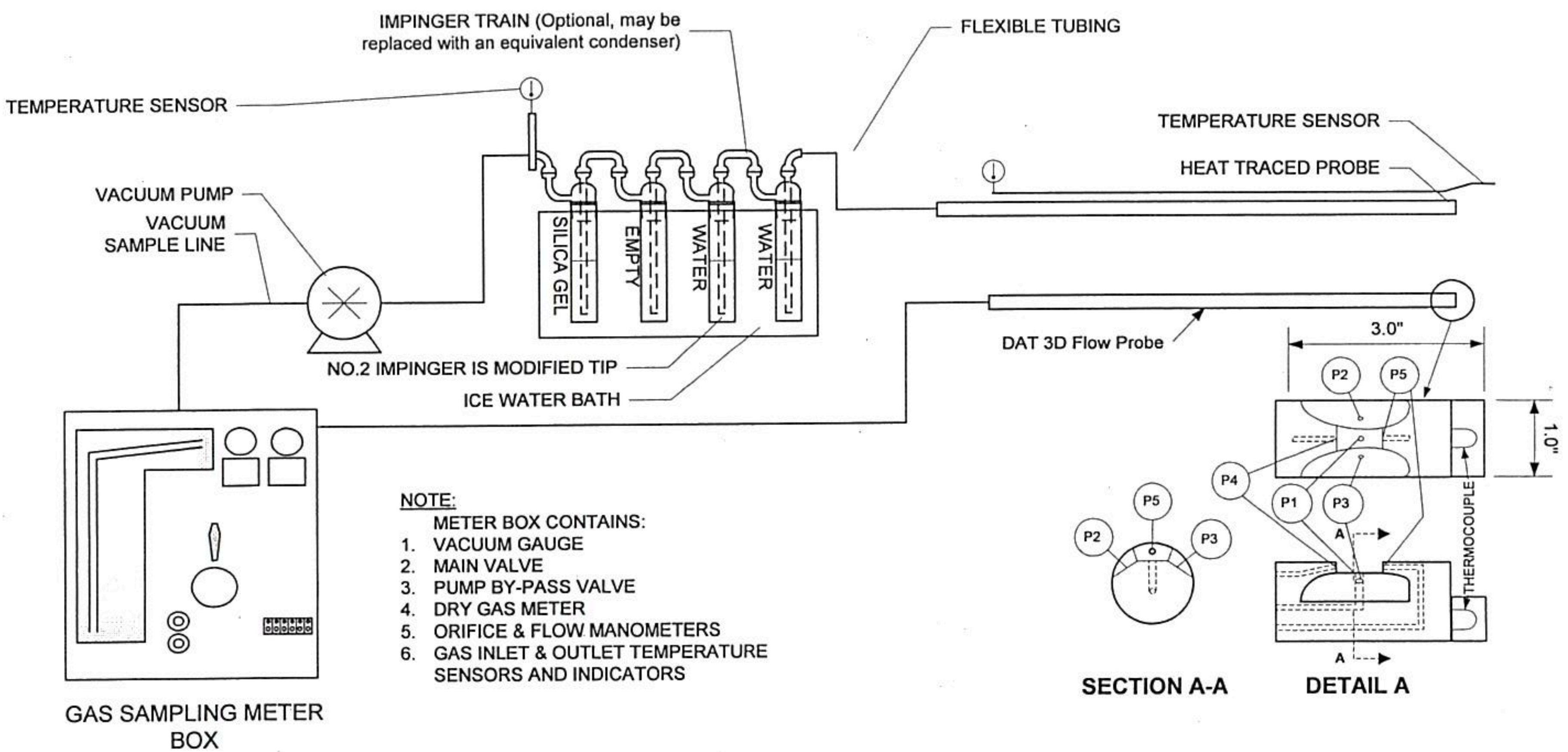
TITLE		
UGI DEVELOPMENT COMPANY - HUNLOCK STATION		
DESCRIPTION: UNIT 6 TEST PORT CONFIGURATION		DATE: 7/24/98
SCALE: NONE	DRAWN BY: MJ TAYLOR	REVISED:

CATALYST AIR MANAGEMENT, INC.



TITLE EPA INSTRUMENTAL SAMPLE TRAIN		
DESCRIPTION SAMPLE TRAIN SCHEMATIC		DATE 01-26-98
SCALE NONE	DRAWN BY RF COBB	REVISED

CATALYST AIR MANAGEMENT, INC.



NOTE:

METER BOX CONTAINS:

1. VACUUM GAUGE
2. MAIN VALVE
3. PUMP BY-PASS VALVE
4. DRY GAS METER
5. ORIFICE & FLOW MANOMETERS
6. GAS INLET & OUTLET TEMPERATURE SENSORS AND INDICATORS

TITLE: EPA METHOD 2F-4 SAMPLING TRAIN		
DESCRIPTION: 3-D FLOW & MOISTURE		DATE: 01-26-98
SCALE: NONE	DRAWN BY: RF COBB	REVISED: 9/8/2004

ATTACHMENT 2

Field Data Sheets

CATALYST AIR MANAGEMENT Inc.
TESTING SERVICES GROUP

DATE: ________ **RUN #:** ________

CLIENT: ____________________ **PLANT:** ________ **UNIT:** ________

Analyzer: O_2 | $CO2$ | NOx

Scale: ________ | ________ | ________

	TIME:	Zero Gas:	Mid-Range:	High-Range:	Zero Gas:	Mid-Range:	High-Range:	Zero Gas:	Mid-Range:	High-Range:
Cylinder Value										
Analyzer Calib.										
System Calib.										
Run 1 Start:										
End:										
System Calib.										
Run 2 Start:										
End:										
System Calib.										
Run 3 Start:										
End:										
System Calib.										
Run 4 Start:										
End:										
System Calib.										
Run 5 Start:										
End:										
System Calib.										
Run 6 Start:										
End:										
System Calib.										
Run 7 Start:										
End:										
System Calib.										
Run 8 Start:										
End:										
System Calib.										
Run 9 Start:										
End:										
System Calib.										
Run 10 Start:										
End:										
System Calib.										
Run 11 Start:										
End:										
System Calib.										
Run 12 Start:										
End:										

CATALYST AIR MANAGEMENT Inc. **PAGE 2**
TESTING SERVICES GROUP

DATE: ______ **RUN #:** ______

Analyzer: SO_2 ______ ______

Scale: ______ ______ ______

	TIME:	Zero Gas:	Mid-Range:	High-Range:	Zero Gas:	Low-Range:	Mid-Range:	High-Range:	Zero Gas:	Mid-Range:	High-Range:
Cylinder Value											
Analyzer Calib.											
System Calib.											
Run 1 Start:											
End:											
System Calib.											
Run 2 Start:											
End:											
System Calib.											
Run 3 Start:											
End:											
System Calib.											
Run 4 Start:											
End:											
System Calib.											
Run 5 Start:											
End:											
System Calib.											
Run 6 Start:											
End:											
System Calib.											
Run 7 Start:											
End:											
System Calib.											
Run 8 Start:											
End:											
System Calib.											
Run 9 Start:											
End:											
System Calib.											
Run 10 Start:											
End:											
System Calib.											
Run 11 Start:											
End:											
System Calib.											
Run 12 Start:											
End:											

CATALYST AIR MANAGEMENT Inc.
TESTING SERVICES GROUP

FLOW DATA

CLIENT: ______________ RUN #: ______________ PROBE ID: ______________
PLANT: ______________ LOAD: ______________ TC ID: ______________
DATE: ______________ STATIC: ______________ Pre Leak: ______________
UNIT: ______________ BAROMETER: ______________ Post Leak: ______________

TIME (24 HR. CLOCK)	SAMPLE POINT	STACK TEMP °F	Yaw Angle degrees	Velocity Pressure (P1-P2)	Pitch Pressure (P4-P5)

MOISTURE DATA

Meter Box: ______________ Yi: ______________

POINT	CLOCK TIME	RUN TIME	DRY GAS METER	ORIFICE PRESSURE	METER TEMP °F INLET	OUTLET
		0				
		5				
		10				
		15				
		20				
		25				
		30				

IMPINGERS ______________
____
____
FINAL VOLUME ______________
INITIAL VOLUME 200
NET VOLUME ______________

SILICA GEL
FINAL WEIGHT ______________
INITIAL WEIGHT ______________
NET WEIGHT ______________

IMPINGERS ______________
SILICA GEL
TOTAL MOISTURE ______________

ATTACHMENT 3

Sample Calculations

SAMPLE EQUATIONS
FOR CEMS RELATIVE ACCURACY TEST AUDITS

CALCULATIONS FOR FLUE GAS VOLUME AND MOISTURE

Time	Dry Gas Meter Ft^3	Pitot ΔP In. H_2O	Orifice ΔH In. H_2O	Dry Gas Temp.°F In Out	Flue Gas Static Pressure In. H_2O	Stack Temp °F
T	V_m	Δp	ΔH	TMI TMO	P_g	T_s

1. P_{bar} = Barometric Pressure (in. Hg)

2. TT = Net Sampling Time (minutes)

3. $V_m = V_m$ Final - V_m Initial = Sample Gas Volume (Ft^3)

4. T_m = Average Dry Gas Temperature at Meter (°F)

$$T_m = \frac{Avg.TMI + Avg.TMO}{2}$$

5. Δp = Velocity head of stack gas (in. H_2O)

6. ΔH = Average Orifice Pressure Drop (in.H_2O)

7. Volume of dry gas sampled at standard conditions[a] (DSCF)

$$V_{m(std)} = \frac{(17.64)(V_m)(Y)\left(P_{bar} + \frac{\Delta H}{13.6}\right)}{(T_m + 460)}$$

8. V_{lc} = Total Water Collected = gm H_2O Silica gel + ml Imp. H_2O = ml

9. Volume of water vapor at standard conditions[b] (SCF)

$$V_{w(std)} = 0.0471(V_{lc}) = SCF$$

10. Percent moisture in flue gas

$$\% M = \frac{100(V_{w(std)})}{V_{m(std)} + V_{w(std)}}$$

11. Mole fraction of water vapor in flue gas

$$B_{ws} = \frac{\% M}{100}$$

12. Molecular Weight of dry flue gas

$$M_d = 0.44(\% CO_2) + 0.32(\% O_2) + 0.28(\% N_2 + \% CO)$$

13. Molecular weight of wet flue gas

$$M_s = M_d(1 - B_{ws}) + 18(B_{ws})$$

14. A = Cross-sectional area of stack (Ft^2)

$$\frac{\pi r^2}{144}$$

15. P_s = Flue gas pressure (in, Hg)

$$P_s = P_{bar} + P_g$$

NOTE: $$P_g(Hg) = \frac{P_g(in.H_2O)}{13.6}$$

16. T_s = Absolute stack temperature (°R)

$$T_s = 460 + t_s$$

17. Flue velocity at stack conditions (FT/SEC)

$$V_s = (K_p)(C_p)\left[\left(\sqrt{\Delta p}\right)avg\right]\sqrt{\frac{T_s(avg)}{P_s * M_s}}$$

C_p = pitot tube coefficient
K_p = pitot tube constant = 85.49ft/sec

18. Flue gas volumetric flow rate at standard conditions[b] (SCFM)

$$Q_s = (V_s)(A)\left(\frac{528}{T_s(avg.)}\right)\left(\frac{P_s}{29.92}\right)(60)$$

19. Flue gas volumetric flow rate at standard conditions[c] (DSCFM)

$$Q_{sd} = (1 - B_{ws})(V_s)(A)\left(\frac{528}{T_s(avg.)}\right)\left(\frac{P_s}{29.92}\right)(60)$$

20. Flue gas volumetric flow rate at stack conditions (ACFM)

$$Q_a = (V_s)(A)(60)$$

NOTES:
[a]Dry standard cubic feet at 68°F, 29.92 in. Hg
[b]Standard conditions at 68°F, 29.92 in. Hg
[c]Dry standard cubic feet per minute at 68°F, 29.92 in. Hg

CALCULATIONS FOR 3-D PITOT TUBE VELOCITY

RESULTANT ANGLE R_i

$$R_I = \text{arc cosine} [(\text{cosine } Yi) * (\text{cosine } Pi)]$$

AXIAL VELOCITY

$$V_I = Kp * F_2 * [Ti (P_1\text{-}P_2)/(Pa * Ms)]^{0.5} * (\text{cosine } Yi) * (\text{cosine } Pi)$$

V_i	=	Velocity at point i, fps
Kp	=	Conversion factor 85.49
Ti	=	Absolute stack temperature at point i, °R
P_1-P_2	=	Pressure differential from 3-D probe, in H_2O
Pa	=	Absolute stack pressure, in Hg
Ms	=	Molecular weight of stack gas, lb/lb-mole
F_2	=	3-D pitot coefficient, [(Pt-Ps)/P_1-P_2)]
Pt-Ps	=	Velocity pressure from standard type pitot, in H_2O
C_{ps}	=	Standard pitot tube coefficient

CALCULATION FOR GAS CONCENTRATION

GAS CONCENTRATION (C_{gas})

$$C_{gas} = \left(\overline{C} - C_0\right)\left(\frac{C_{ma}}{C_m - C_o}\right)$$

C_{gas}	=	Effluent gas concentration, ppm
$\overline{C}$	=	Average gas concentration indicated by gas analyzer, dry basis, ppm
C_0	=	Average of initial and final system calibration bias check responses for the zero gas, ppm
C_m	=	Average of initial and final system calibration bias check responses for the upscale calibration gas, ppm
C_{ma}	=	Actual concentration of the upscale calibration gas, ppm

GAS CONCENTRATION @ 15% O_2 (C_{gas} @ 15% O_2)

C_{gas} @ 15% O_2 = C_{gas} * ((20.9-15)/(20.9-%O_2))

GAS CONCENTRATION @ 7% O_2 (C_{gas} @ 7% O_2)

C_{gas} @ 7% O_2 = C_{gas} * ((20.9-7)/(20.9-%O_2))

GAS CONCENTRATION @ 3% O_2 (C_{gas} @ 3% O_2)

C_{gas} @ 3% O_2 = C_{gas} * ((20.9-3)/(20.9-%O_2))

F-FACTOR DETERMINATION

THE WET F-FACTOR (F_w):

Includes all components of combustion

$$F_w = \frac{10^6\, Btu / mmBtu\left[5.57(\%H) + 1.53(\%C) + 0.57(\%S) + 0.14(\%N) - 0.46(\%O_2) + 0.21(\%H_2O)\right]}{GCV_{wet}}$$

THE DRY F-FACTOR (F_d):

Includes all components of combustion less water

$$F_d = \frac{10^6\, Btu / mmBtu\left[3.64(\%H) + 1.53(\%C) + 0.57(\%S) + 0.14(\%N) - 0.46(\%O_2)\right]}{GCV_{dry}}$$

THE CARBON F-FACTOR (F_c):

Includes only Carbon Dioxide

$$F_c = \frac{10^6\, Btu / mmBtu\left[0.321(\%C)\right]}{GCV_{dry}}$$

References for the above equations (i.e. %H, %C, %N, %S, $\%O_2$) can be found in 40 CFR Part 60, Appendix A, Method 19.

LBS/MMBTU CALCULATIONS USING THE F-FACTOR

1. EMISSION RATE *E(lb/mmbtu)*, O_2 based

$$E(lb/mmbtu) = C \times F_d\left(\frac{20.9}{20.9 - \%O_2}\right)$$

Where:

C(lb/dscf) = Pollutant concentration (ppm) x conversion factor.

Conversion Factors:

$NOx = 1.194 \times 10^{-7}$

$SO_2 = 1.660 \times 10^{-7}$

$CO = 7.274 \times 10^{-8}$

$C_3H_8 = 1.145 \times 10^{-7}$

F_d*(dscf/mmbtu)* = "F" Factor for fuel type, (Ref. EPA Method 19)

F_d (Coal) = 9780

F_d (Gas) = 8710

F_d (Oil) = 9190

2. EMISSION RATE *E(lb/mmbtu)*, CO_2 based

$$E(lb/mmbtu) = C \times F_c\left(\frac{100}{\%CO_2}\right)$$

Where:

C(lb/dscf) = Pollutant concentration (ppm) x conversion factor.

Conversion Factors:

$NOx = 1.194 \times 10^{-7}$

$SO2 = 1.660 \times 10^{-7}$

$CO = 7.274 \times 10^{-8}$

$C_3H_8 = 1.145 \times 10^{-7}$

F_c*(dscf/mmbtu)* = "F" Factor for fuel type, (Ref. EPA Method 19)

F_d (Coal) = 1800

F_d (Gas) = 1040

F_d (Oil) = 1420

CALCULATION OF RELATIVE ACCURACY

ARITHMETIC MEAN (OF THE DIFFERENCE , {d}, OF A DATA SET)

$$\bar{d} = \frac{1}{n}\sum_{i=1}^{n} d_i$$

Where n = Number of data points.

ALGEBRAIC SUM (OF THE INDIVIDUAL DIFFERENCES, $\{d_i\}$)

$$\sum_{i=1}^{n} d_i$$

STANDARD DEVIATION, S_d

$$S_d = \sqrt{\frac{\sum_{i=1}^{n} d_i^2 - \left(\frac{\left(\sum_{i=1}^{n} d_i\right)^2}{n}\right)}{n-1}}$$

CONFIDENCE COEFFICIENT, CC

$$CC = t_{0.975}\frac{S_d}{\sqrt{n}}$$

For 9 tests $t_{0.975} = 2.306$

For 10 tests $t_{0.975} = 2.262$

For 11 tests $t_{0.975} = 2.228$

For 12 tests $t_{0.975} = 2.201$

RELATIVE ACCURACY, RA

$$RA = \frac{|\bar{d}| + |CC|}{\overline{RM}} x100$$